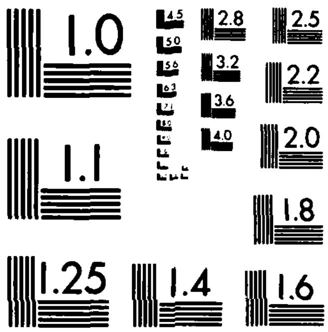
AD-A152 928 CONSTRUCTION TECHNIQUES OF A MOLECULAR HYDROGEN LASER (U) ARIZONA UNIV TUCSON DEPT OF CHEMISTRY J S BABIS ET AL. 20 MAR 85 TR-38 N00014-83-K-0268 1/1

UNCLASSIFIED F/G 20/5 NL

END
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

(2)

AD-A152 928

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 38	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Construction Techniques of a Molecular Hydrogen Laser		5. TYPE OF REPORT & PERIOD COVERED Interim
		6. PERFORMING ORG. REPORT NUMBER
AUTHOR(s) Jeffery S. Babis, Thomas C. Huth and M. Bonner Denton		8. CONTRACT OR GRANT NUMBER(s) N00014-83-K-0268
PERFORMING ORGANIZATION NAME AND ADDRESS Department of Chemistry University of Arizona Tucson, AZ 85721		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NR 051-549
CONTROLLING OFFICE NAME AND ADDRESS Office of Naval Research Arlington, VA 22217		12. REPORT DATE March 20, 1985
		13. NUMBER OF PAGES 8
MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

This document has been approved for public release and sale; its distribution is unlimited.

DTIC
ELECTE
APR 2 5 1985
S D
B

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Prepared for publication in the Review of Scientific Instruments

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Lasers

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Simple techniques are described for construction of a discharge channel, and spark gap trigger electrode for a travelling-wave excited molecular hydrogen laser.

DTIC FILE COPY

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

S/N 0102-LF-014-6601

85 4 1 065

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

OFFICE OF NAVAL RESEARCH

Contract N00014-83-K-0268

Task No. NR 051-549

TECHNICAL REPORT NO. 38

Construction Techniques of a Molecular Hydrogen Laser

by

Jeffery S. Babis,* Thomas C. Huth‡ and M. Bonner Denton‡

Prepared for Publication

in the

Review of Scientific Instruments

*Beckman Instruments
P.O. Box C-19600
Irvine, CA 92713

‡Department of Chemistry
University of Arizona
Tucson, AZ 85721

March 20, 1985

CONSTRUCTION TECHNIQUES OF A MOLECULAR HYDROGEN LASER

by

Jeffery S. Babis
Beckman Instruments, Inc.
P.O. Box C-19600
Irvine, California 92713

Thomas C. Huth and M. Bonner Denton
Department of Chemistry
University of Arizona
Tucson, Arizona 85721

Abstract

Simple techniques are described for construction of a discharge channel, and spark gap trigger electrode for a travelling-wave excited molecular hydrogen laser.

In the past few years the quest for intense vacuum ultraviolet spectroscopic sources has increased tremendously. Among the sources developed has been a large number of gas lasers, one of which is the relatively simple molecular hydrogen laser.[1-6] The hydrogen laser emission consists of several lines near 160 nm providing energies in the range of 7.7 to 7.9 electron volts per photon, sufficient for a variety of photochemical applications. The advantage of the Blumlein transverse gas-discharge excitation laser design lies in its inherent simplicity and convenience of operation. However, one component, the laser discharge channel, has dimensions which are critical in obtaining the uniform and extremely high pumping power density necessary for proper operation.

Goldsmith and Knyazev have shown that a discharge channel height of approximately 300 μm will produce the optimum in output energy.[7] The distance between the 2 electrode edges must be constant along the entire channel length and the glass plates forming the channel must be parallel. This paper describes a simple technique which has worked quite well in our laboratory for constructing laser discharge channels which fit these critical requirements. We also note our technique for fabricating a trigger electrode assembly for the low-inductance triggered spark gap used to switch the discharge.

The first step in the construction process was to make two identical half channels as seen in Figure 1a. The finished outside dimensions of the typical discharge channel were 3.8 cm wide by 43 cm long. The height of a standard channel was 19 mm and that of a channel with a cooling jacket was 4.4 cm. The stainless steel electrodes were 0.010" thick and 41 cm by 15 cm with each corner rounded to a radius of 1 cm. The long edge of each

electrode was bent 90 degrees 1 mm from that edge. Epoxy was used to assemble the 4 pieces of each half. Two mm thick spectroscopic quality glass pane was used for the surfaces forming the channel while 1/4" thick window glass was used as a base plate. Each half was sandwiched between 2 glass optical flats while the epoxy cured. While the epoxy was still leathery, however, a moto-tool with a wire brush attachment was used to remove the excess adhesive from the electrode surfaces. Approximately 70 kilograms of lead bricks were used to weigh down the assembly when sandwiched between the optical flats.

The most important part of the construction was to insure that the plates forming the discharge channel were parallel. This was accomplished with the use of a frame containing two tautly drawn piano wires. The wires, which had a tolerance of 0.0002", were used to form the channel height between the two half assemblies. The wires rested on one half and supported the other while the epoxy cured. This method of construction required that the dimensions of the aluminum frame were larger than the optical flats. The frame had two 1 mm holes in each end separated by 10 mm, each opposing pair containing a wire. Two different string diameters resulting in two channel heights have been investigated each with equal success. Channel heights of 255 and 330 μm were constructed from 0.010" and 0.013" strings. Other channel heights have also been accomplished with piano wire of other diameters.

When the epoxy had cured, the wires were cut and pulled through the laser channel, which is depicted in Figure 1b. The channel was completed by constructing 2 polymethyl methacrylate endpieces. Each of these pieces included a gas inlet and an o-ring groove for the calcium fluoride optics.

When the laser was operated in excess of 60 Hz for more than a few minutes, the channel heated excessively, requiring cooling. Two 'C' shaped channels were therefore glued to the top and bottom of the discharge channel as depicted in Figure 1c. Cooling water was run through the assembly at a rate of about 4 liters/minute. With this cooling capability, the laser was able to be operated in excess of 250 Hz for an hour or more without difficulty.

Switching of high-voltage to the channel is accomplished using a nitrogen-pressurized triggered spark gap switch. Initially, the trigger electrode assembly for this device was constructed using a tungsten tip brazed to a length of copper wire, which was then suspended inside a borosilicate glass tube filled with epoxy.[7] When the spark gap containing this assembly was opened after a period of operation, a black residue was observed, coating the entire inside surface of the spark gap housing. We speculated that this residue resulted from epoxy sputtered from the exposed base of the trigger electrode tube by the plasma discharge. We therefore built a new electrode assembly, using a thoriated tungsten rod inserted through a length of 7 mm borosilicate glass capillary tubing, sealed with a drop of epoxy at the top end only. This was, in turn, inserted into the 3/8-inch stainless steel electrode sleeve and sealed in the same manner at the top only (Figure 2). This modification resulted in marked improvement of pulse reproducibility in our laser. Reinspection of the spark gap interior after operation revealed a small amount of powdery dark green residue still present, which is likely Cu_3N formed in the plasma. This material does not appear to affect laser performance, but it can nevertheless be easily removed using a dilute acid swab.

Acknowledgments
This work was supported in part by the Office of Naval Research.

References

1. R. T. Hodgson, Phys. Rev. Lett. 25, 494 (1970).
2. R. W. Waynant; J. D. Shipman, Jr.; R. C. Elton and A. W. Ali, Appl. Phys. Lett. 17, 383 (1970).
3. R. W. Waynant; J. D. Shipman, Jr.; R. C. Elton and A. W. Ali, Proc. IEEE 59, 679 (1971).
4. V. S. Antonov; I. N. Knyazev; V. S. Letokhov and V. G. Movshev, JETP Lett. 17, 393 (1973).
5. I. N. Knyazev; V. S. Letoknov and V. G. Movshev, IEEE J. Quant. Electr. QE-11, 805 (1975).
6. R. W. Waynant and R. C. Elton, Proc. IEEE 64, 1059 (1976).
7. J. E. Goldsmith and I. N. Knyazev, J. Appl. Phys. 48, 4912 (1977).

Figure Captions

Figure 1. Cross-section of laser discharge channel: a) Half-cell; b) Completed standard channel; c) Channel with cooling jacket

Figure 2. Trigger electrode assembly

Figure 3. Exploded diagram of laser

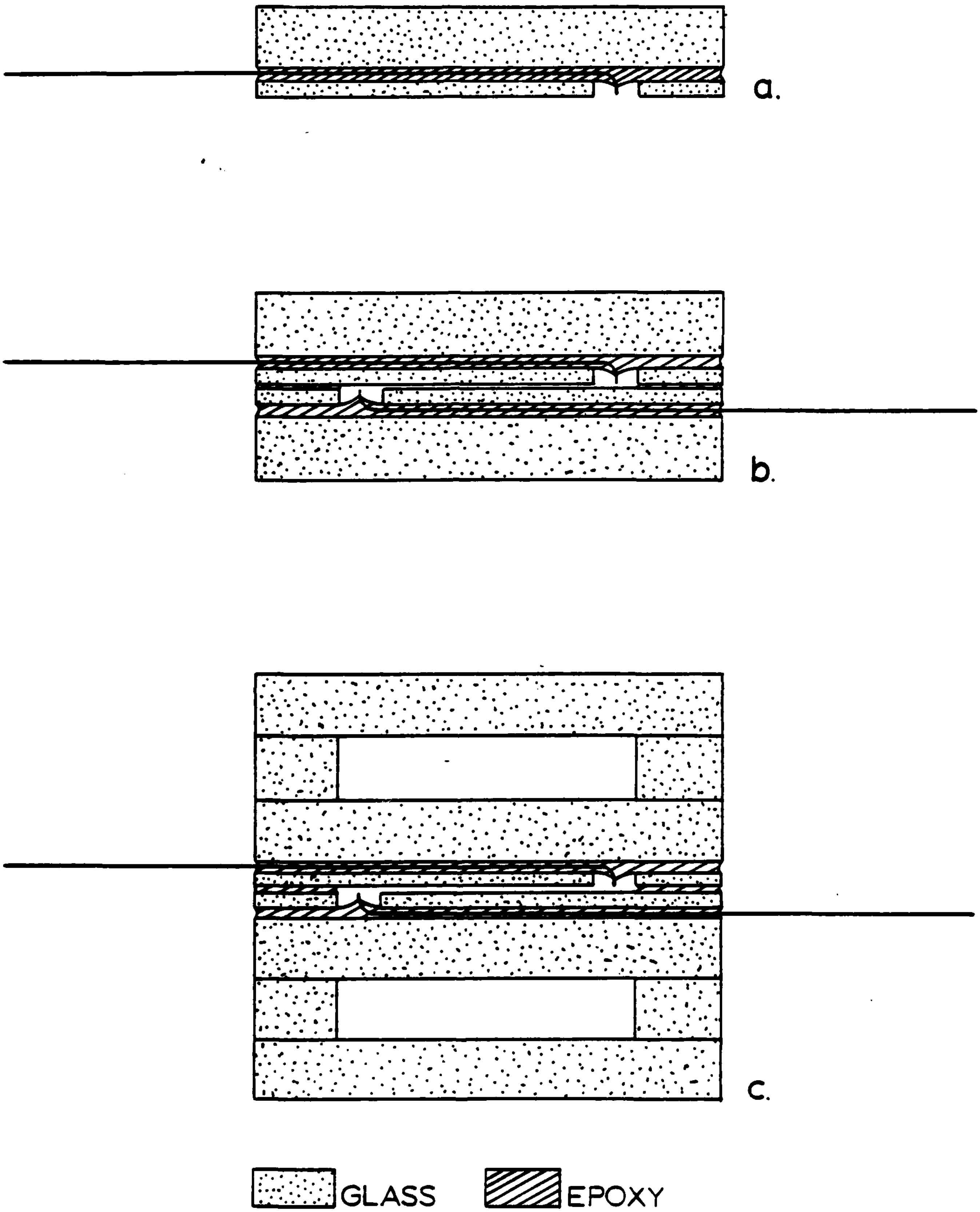


Figure 1

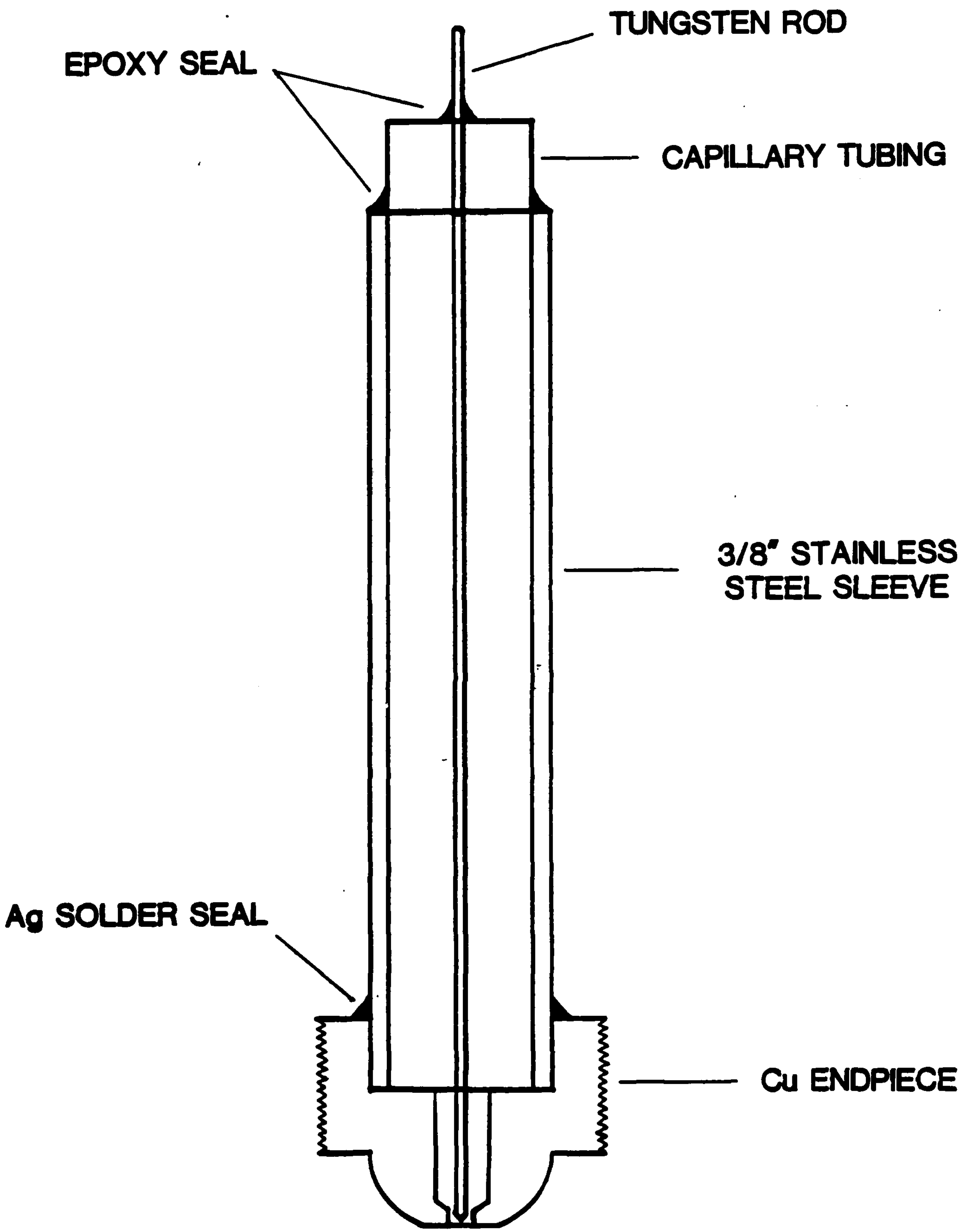

TUNGSTEN ROD
EPOXY SEAL
CAPILLARY TUBING
3/8" STAINLESS
STEEL SLEEVE
Ag SOLDER SEAL
Cu ENDPIECE

Figure 2

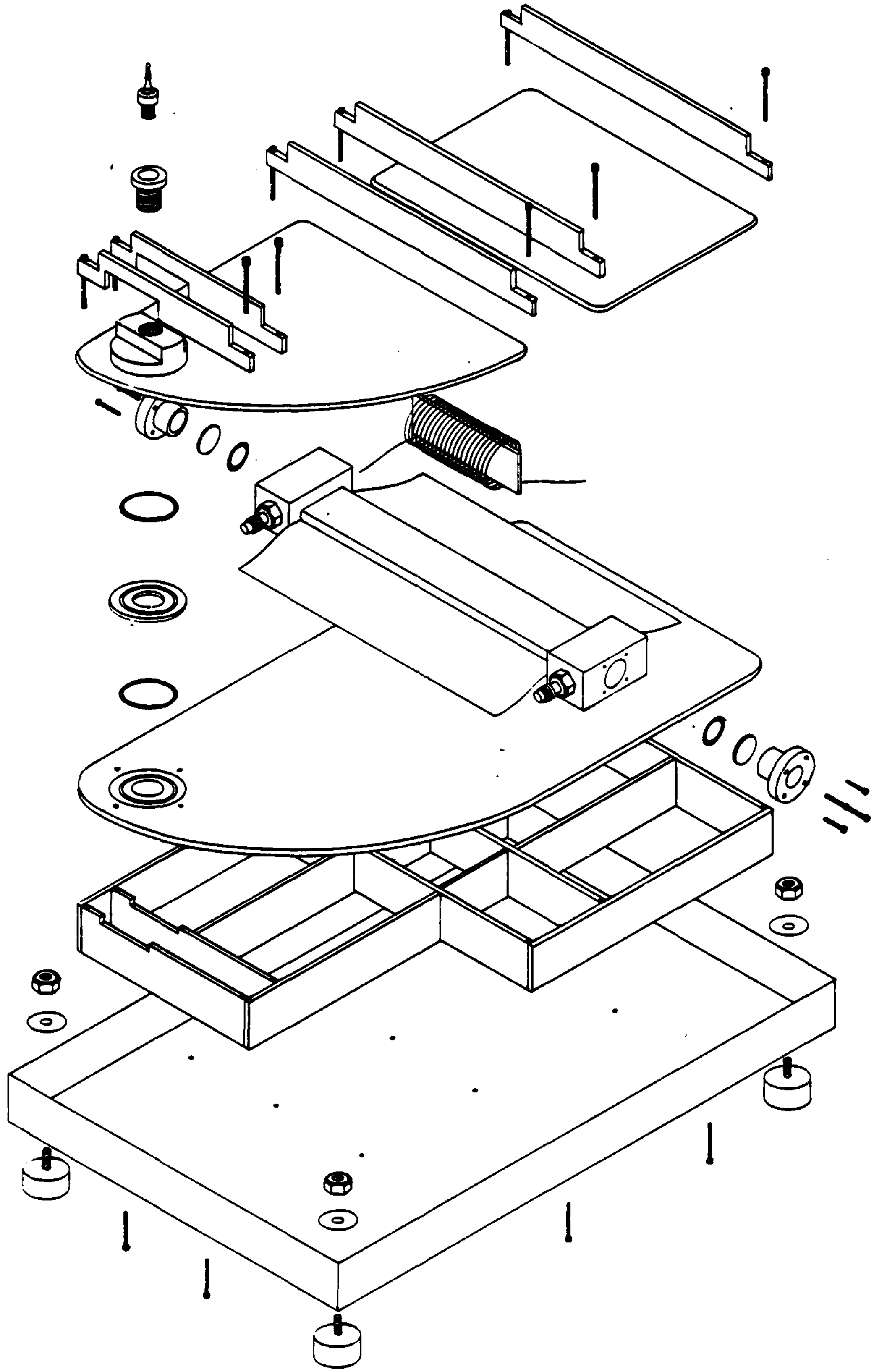


Figure 3

TECHNICAL REPORT DISTRIBUTION LIST, GEN

	No. Copies		No. Copies
Office of Naval Research Attn: Code 413 800 N. Quincy Street Arlington, Virginia 22217	2	Dr. David Young Code 334 NORDA NSTL, Mississippi 39529	1
Dr. Bernard Douda Naval Weapons Support Center Code 5042 Crane, Indiana 47522	1	Naval Weapons Center Attn: Dr. A. B. Amster Chemistry Division China Lake, California 93555	1
Commander, Naval Air Systems Command Attn: Code 310C (H. Rosenwasser) Washington, D.C. 20360	1	Scientific Advisor Commandant of the Marine Corps Code RD-1 Washington, D.C. 20380	1
Naval Civil Engineering Laboratory Attn: Dr. R. W. Drisko Port Hueneme, California 93401	1	U.S. Army Research Office Attn: CRD-AA-IP P.O. Box 12211 Research Triangle Park, NC 27709	1
Defense Technical Information Center Building 5, Cameron Station Alexandria, Virginia 22314	12	Mr. John Boyle Materials Branch Naval Ship Engineering Center Philadelphia, Pennsylvania 19112	1
DTNSRDC Attn: Dr. G. Bosmajian Applied Chemistry Division Annapolis, Maryland 21401	1	Naval Ocean Systems Center Attn: Dr. S. Yamamoto Marine Sciences Division San Diego, California 91232	1
Dr. William Tolles Superintendent Chemistry Division, Code 6100 Naval Research Laboratory Washington, D.C. 20375	1		

END

FILMED

5-85

DTIC